

MASTER OF SCIENCE IN AERONAUTICAL ENGINEERING

INVESTIGATION OF CROSS FLOW FAN PROPULSION FOR LIGHTWEIGHT VTOL AIRCRAFT

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As world population increases, road and airport congestion will become increasingly prevalent. A small, cheap VTOL aircraft which can be flown from a driveway to the workplace parking lot would reduce traffic congestion and travel time. A lightweight, single seat commuter type VTOL aircraft is envisioned as the solution to this problem. To achieve a goal of minimum weight, the aircraft aerodynamic design should be optimized for forward flight. Vertical thrust augmentation from a propulsion unit contained within the fuselage would have little detriment to forward flight aerodynamics, and the cross flow fan can be accommodated as such. Cross flow fan propulsion has not been seriously considered for aircraft use since an LTV Vought Systems Division study for the U.S. Navy in 1975. Despite an indepth knowledge of the design parameters and airflow relationships in cross flow fans, the existing data supports the hypothesis that with further development the thrust efficiency and thrust-to-weight ratio could improve to the point where this thrust producing method is viable. This study investigates the incorporation of rotary engine powered cross flow fan propulsion in a hypothetical lightweight VTOL aircraft and concludes that cross flow fan propulsion is viable but only with further investigation of power plant technology and fan design parameters and relationships.

DoD KEY TECHNOLOGY AREAS: Aerospace Propulsion and Power, Air Vehicles

KEYWORDS: VTOL, Cross Flow Fan, Ducted Propeller

COMPUTERIZED BALLISTIC MODELING OF THE COMANCHE TAILFAN SHROUD

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The U.S. Army has contracted Boeing-Sikorsky to develop the RAH-66 Comanche, a new, armed reconnaissance helicopter that features stealth technology designed to improve survivability when operating in hostile environments. Ballistic testing is required on the Comanche prior to fielding. Computer based simulations are being employed in order to reduce requirements for expensive live-fire testing. This thesis uses a computer program called Dytran from MacNeal-Schwendler to simulate the effects of an explosive round detonating in the Comanche tailfan shroud. Six test cases involving explosions with varying amounts of explosive energy, or specific internal energy, are evaluated. From these tests, a curve showing the percentage of structural failure versus the specific internal energy is plotted. Assuming that 20% structural failure of the model equates to a catastrophic failure, this analysis shows that the analyzed section of the Comanche tailfan shroud can withstand an explosion with a specific internal energy of $2.58 * 10^{10}$

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in^2/sec^2 . Any potential threat rounds with specific internal energies greater than $2.58 * 10^{10} \text{ in}^2/\text{sec}^2$ will pose serious threats to the Comanche.

DoD KEY TECHNOLOGY AREAS: Air Vehicles, Materials, Processes and Structures, Modeling and Simulation

KEYWORDS: Comanche, Ballistic Modeling, Dytran, Tailfan Shroud